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ICESat (GLAS) Science Processing Software Document Series

Volume 3
GLAS Science Software Requirements Document
Version 2.1

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February 2001

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Foreword

This document addresses the software requirements of the GLAS Standard Data Software (SDS) supporting the GLAS instrument on the EOS ICESat Spacecraft. The SDS encompasses major portions of both the ICESat Science Investigator-led Processing System (I-SIPS) Software and the Instrument Support Terminal (IST) Software. For the I-SIPS Software, the SDS will produce Level 0, Level 1A, Level 1B, and Level 2 data products as well as the associated product quality assessments. For the IST, the SDS software will accommodate the GLAS instrument support areas of engineering status, command, performance assessment, and instrument health status.

The GLAS Standard Data Software is being constructed within the framework and model presented by the NASA Software Documentation Standard, i.e., the Standard (NASA-STD-2100-91). An important tenet of the NASA Software Engineering Program is to record the essential information in the project documentation. This documentation provides the information necessary to support and sustain the development life cycle and the maintenance of the software system.

This Software Requirements Document represents the initial collection of the technical engineering information for the GLAS Standard Data Software. This information is detailed within the second of four main volumes of the Standard documentation, the Product Specification volume. This document is a "roll-out" from the governing volume outline containing the Concept and Requirements sections.

This GLAS Science Software Requirements Documnet has been prepared by Raytheon/ITSS under contract NAS5-00181 with the NASA Goddard Space Flight Center, Greenbelt, Md. This document was prepared in support of Dr. Bob E. Schutz, GLAS Science Team Leader, for the GLAS Science Investigation. This work was performed under the direction of David W. Hancock, III, GLAS Standard Data Software Development Team Leader, Observational Science Branch, Laboratory for Hydrospheric Processes, NASA Goddard Space Flight Center, Wallops Flight Facility, Wallops Island, Virginia, who may be contacted at (757) 824-1238, hancock@osb1.wff.nasa.gov (e-mail), or (757) 824-1036 (Fax).

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Section 1

Introduction

1.1 Identification of Document

This is the Software Requirements Document of the GLAS Standard Data Software (SDS). This document contains the Concept and Requirements documentation for the Standard Product Specification Volume.

This software requirements document is the first document "rolled out" of the specification volume. This document is specified as a deliverable in the GLAS Standard Data Software Documentation Tree in the GLAS Science Software Management Plan. It is identified as the GLAS Science Software Requirements Document (GSSRD), document number GLAS-PRS-2100 in the document numbering scheme in compliance with the software management plan.

Successive editions of this document will be uniquely identified by the document version and date marks on the cover and individual page footers. For brevity this document will be referred to throughout the subsequent text as the GSSRD.

1.2 Scope of Document

This document encompasses the software project concepts and requirements imposed on the GLAS Standard Data Software by the EOS mission level and the GLAS Science Investigation. This document is produced as a responsibility of the GLAS Standard Data Software Development Team under the direction of the GLAS Science Team Leader.

This document is applicable to the GLAS Standard Data Software consisting of the ICESat Science Investigator-led Processing System (I-SIPS) Software and the GLAS Instrument Support Terminal (IST) Software.

1.3 Purpose and Objectives of Document

The purpose of the GLAS Science Software Requirements Document is to specify the requirements imposed on the GLAS Standard Data Software. This requirements specification document represents the initial document roll-out of the product specification volume under the NASA software engineering standards. The GSSRD conforms with the outline topics included in the concept and requirements templates in the NASA software engineering document.

The following objectives are identified for this requirements specification:

- The GSSRD is to represent a collection of those identified, definable, real requirements that have a governing impact or influence upon the development of the SDS.

- These requirements are traceable to either an external source such as an ESDIS Project document, or an internal source such as a GLAS Science Team or Instrument Team document.
- Wherever a newly defined requirement is introduced within this document, it will clearly be identified that it is a derived requirement within the GSSRD (i.e., not specified in or inherited from other sources), and a validation for the requirement will be supplied.
- This requirements specification will be an incremental, living document containing a baseline core of requirements. Subsequent issues will present newly identified and add-on requirements as they are determined.
- The final GSSRD will be a uniform, complete collection of requirements applicable to the GLAS SDS. While the document is intended to be incremental in its development, it is to be considered as the single-source list of requirements imposed on the software development effort. The requirements are to presented in a concise form with traceability to the source document or authority as the detailed description of the requirement.
- The GSSRD format and contents are based on the document templates in the NASA software engineering standards document. As such, it seeks to remain consistent with the organization and intended content of those sections to at least a top-level of detail. The conformity to this information format is a goal throughout the life cycle of this document.
- The GSSRD is the first product specification document roll-out. The GSSRD is a predecessor to the GLAS Science Software Architectural Design Specification. This document will be limited to the specification of requirements, and will avoid extension or encroachment into the design documentation segment of the design phase.
- The requirements collection is expanded with the inclusion of constraints that are imposed upon the development and implementation of the software system as well.

1.4 Document Status and Schedule

This requirements specification is Version 1.2 of the GLAS Science Software Requirements Document. Subsequent editions of the document will include any additional ESDIS Project, instrument, and investigation team requirements which are related to the Standard Data Software.

1.5 Document Organization

The organization of the GLAS Science Software Requirements Document is based on the Concept and Requirements sections of the Product Specification Volume under the NASA software engineering program documentation standards. The standards are obtained from the *NASA Software Documentation Standard Software Engineering Program* document [Reference 2.2a].

Sections 1 and 2 contain the introductory and reference document information for the GSSRD. Section 3 contributes the organization for the standard Concept section. It represents an abbreviated, condensed composition of the section template from the documentation standards. The concept section is effectively rolled up into this requirements specification as a portion of the document.

Section 4 contains the core and incremental collection of the software system requirements. It is subdivided into the primary subsections aligned to a presentation of the I-SIPS Software and the GLAS IST Software components.

The GSSRD appendices list the SDS requirements in one location and provide the traceability of the requirements to their source(s). The GSSRD appendices are then followed by the supplemental information contained in the abbreviations and acronyms and the glossary sections.

Any upper level section and sub-section headings from the document standards template that are not populated with information or are not germane to the scope of the GSSRD will be identified with a not-applicable tag (N/A). Any sections or sub-sections that are supplemental to the standard outline will be denoted as additions.

1.5.1 Document Change History

Document Name: GLAS Science Software Requirements Document		
Version Number	**Date**	**Nature of Change**
Preliminary	**December 31, 1996**	**Original Version**
Version 1.2	**July 1998**	**Updated requirements. Updated with new terminology.**
Version 2.0	**September 30, 1998**	**Updated for change to ICESat Science Investigator-led Processing System.**
Version 2.1	**November 2000**	**Modified requirements for V1.**

Section 2

Related Documentation

This Section provides the bibliography and references for the GLAS Science Software Requirements Document. Document references include parent documents, applicable documents, and information documents.

2.1 Parent Documents

Parent documents are those external, higher-level documents that contribute information to the scope and content of the context and requirements details of the GSSRD. The following GLAS Team documents are parent to this requirements specification document.

a) *GLAS Science Software Management Plan* (GLAS SSMP), Version 2.2, July 1998, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-SMP-1100.

b) *GLAS Science Data Management Plan* (GLAS SDMP), Version 2.2, July 1998, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-DMP-1200.

The GLAS SSMP is the top-level Volume 1 (Management Plan Volume) document, dictating the creation and maintenance of the GSSRD as a part of the software system development life cycle. The GLAS SDMP represents the immediate predecessor document (also from the Management Plan Volume) and contains details contributing to the data product and interface requirements. Within the four-volume NASA software documentation standards [Reference 2.2c], the Product Specification Volume (Volume 2) follows the Management Volume. There is no overall GLAS Science Software Product Specification [Volume].

2.2 Applicable Documents

Applicable documents to the GSSRD include reference documents that are not parent documents. This category includes reference documents that have direct applicability to, or contain policies binding upon the content of this document. The following ESDIS Project, NASA, or other Agency documents are cited as applicable to this requirements specification document.

a) *NASA Software Documentation Standard Software Engineering Program*, NASA, July 29, 1991, NASA-STD-2100-91.

b) *Science User's Guide and Operations Procedure Handbook for the ECS Project, Volume 4: Software Developer's Guide to Preparation, Delivery, Integration and Test with ECS*, Final, August 1995, Hughes Information Technology Corporation, 205-CD-002-002.

c) *Data Production Software and Science Computing Facility (SCF) Standards and Guidelines*, January 14, 1994, Goddard Space Flight Center, 423-16-01.

d) *EOS Output Data Products, Processes, and Input Requirements*, Version 3.2, November 1995, Science Processing Support Office.

The following GLAS Science Team and Engineering Team documents are cited as applicable to this requirements specification document.

e) *NASA Earth Observing System Geoscience Laser Altimeter System GLAS Science Requirements Document*, Version 2.01, October 1997, Center for Space Research, University of Texas at Austin.

f) *Precision Orbit Determination (POD) Algorithm Theoretical Basis Document*, Version 0.1, December 1996, Center for Space Research of The University of Texas at Austin, GLAS TN 95-014.

g) *Atmospheric Delay Correction to GLAS Laser Altimeter Ranges Algorithm Theoretical Basis Document*, Version 0.3, December 1996, Massachusetts Institute of Technology, GLAS TN 95-011.

h) *Algorithm Theoretical Basis Document for the GLAS Atmospheric Channel Observations*, Version 0, December 1995, Goddard Space Flight Center, GLAS TN 95-012.

i) *Geoscience Laser Altimeter System: Surface Roughness of Ice Sheets*, Algorithm Theoretical Basis Document, Version 0.3, December 1996, University of Wisconsin.

j) *Determination of Sea Ice Surface Roughness from Laser Altimeter Waveform Algorithm Theoretical Basis Document*, Version 0, December 1995, The Ohio State University, GLAS TN 95-010.

k) *Laser Footprint Location and Surface Profiles*, Algorithm Theoretical Basis Document, Version 0 (Preliminary), December 1996, Center for Space Research, The University of Texas at Austin.

l) *Precision Attitude Determination (PAD)*, Algorithm Theoretical Basis Document, December 1996, Center for Space Research, The University of Texas at Austin.

2.3 Information Documents

Information documents are those that are not directly applicable as a reference to this requirements specification document. They are documents providing information that will serve to amplify or clarify concepts or requirements contained in the GSSRD. These information documents will be further identified as to their relationship to the GSSRD, and whether or not their information content is binding or nonbinding on this document.

The following ESDIS Project, NASA, or other Agency documents are cited as providing background or supplemental information to this requirements specification document.

a) *Operations Concept for Integration and Test of Science Data Production Software*, White Paper, March 1995, Hughes Applied Information Systems, Inc., 62-WP-

001-002.

b) *Interface Control Document Between EOSDIS Core System (ECS) and Science Computing Facilities (SCF)*, December 1995, Hughes Information Technology Corporation, 209-CD-005-504.

c) *SDP Toolkit Users Guide for the ECS Project*, August 1995, Hughes Information Technology Corporation, 333-CD-003-002.

Reference documents 2.3a, 2.3b, and 2.3c provide information concerning the Science Data Processing Toolkit and the Science Computing Facility. These documents are initially indicated to provide non-binding information to the GSSRD content.

Section 3

Concept

The following subsections provide a brief overview of the GLAS Standard Data Software (SDS). The functional descriptions and definitions of GLAS SDS capabilities provide the context foundation for the traceable requirements presented in Section 4. For subsequent discussions, the GLAS SDS is subdivided into its functional components as presented in the following section.

3.1 Purpose and Scope

The purpose of the GLAS SDS is to produce the GLAS standard data products and their metadata (descriptive information) and to provide the capability to monitor and operate the GLAS instrument. The GLAS SDS is built under the direction of the GLAS Science Team with support from the Instrument Team. The GLAS SDS does not produce any GLAS supplemental or special data products.

3.2 Goals and Objectives

The following goals and objectives for the GLAS SDS are applicable to all software units regardless of function or scope.

The software units will be developed in accordance with a structured, life cycle development approach as identified in the GLAS Science Software Management Plan.

- Software units will be accompanied by required software system standard documentation.
- The software units will be planned and developed based on a realistic project management timeline. The units' development will recognize and will meet or exceed all Project and GLAS Team milestones for review and delivery.

3.3 Description

The GLAS SDS is subdivided into two major categories: the ICESat Science Investigator-led Processing System (I-SIPS) Software and the GLAS IST Software.

The I-SIPS Software constitutes those software units containing the GLAS science algorithms. These are programs that perform the work of transforming lower level data products into higher level data products. This body of software is specific to those data products identified as the GLAS Standard Data Products. In addition, the I-SIPS Software will support routine data quality assurance and assessment, and metadata production. These software units will be used to monitor the performance of the science data production software.

The major external interfaces of the I-SIPS Software include: the ICESat SCF, the GLAS Science Team, the I-SIPS Team, the Instrument Operations Team, and the

DAAC environment. The I-SIPS Software will utilize the ESDIS-provided SDP Toolkit to perform data product formatting and to interface to the DAAC.

The GLAS IST Software includes the software units that will reside on the GLAS Instrument Support Terminal nodes. These software units will provide instrument health assessment and monitoring, and provide command capabilities for the GLAS Instrument Team. The GLAS IST Software will be operated by the instrument and operations teams.

The GLAS IST Software will interface with the MOC, the GLAS IST environment, and the GLAS Instrument Operations Team. The IST Software will utilize MOC-provided tools.

Section 4

Requirements

This section provides a collective repository for the requirements governing the GLAS Standard Data Software. This repository includes functional, performance, and interface requirements imposed on the key segments of GLAS SDS. The first subsection (4.1) describes the overall approach to determining the requirements and the results of trade-offs. Section 4.1 is applicable to both the I-SIPS and IST Software segments.

The requirements specification subsections (4.2 and 4.3) present the major characteristics for each of the software segments, along with goals pertaining to the design phase and associated constraints on the software implementation phase. Each presented requirement is uniquely identified with an assigned requirements number that will be used to point back to the parent or applicable document. Sufficient information is maintained in an external requirements data base to support traceability of requirements back to the originating document. The parent and applicable document external requirements and traceability information are presented in Appendices A and B respectively. The traceability information is intended to ensure that the source for each requirement and the requirement's location in that document are known.

4.1 Requirements Approach and Identification

The overall requirements approach is a basic collection and analysis process involving the identification of a baseline requirements set. The baseline set contains requirements obtained from parent and applicable document sources. In the Project hierarchy, the contributions are obtained from the GLAS Science Team, the GLAS Instrument Team, and the ESDIS Project. Documents relevant to ESDIS, the EOSDIS Distributed Active Archive Center (DAAC), the Flight Operations Segment (FOS), and the Project-provided Toolkits provide the inherited Project-level requirements details. These are the initial requirements imposed on the I-SIPS Software and the IST Software.

The mission requirements document, the software management plan, the data management plan, the algorithm theoretical basis documents, and the instrument and standard data product specifications form the core of the science investigation and engineering requirements placed on the software.

GLAS Science and Instrument Requirements are to be initially accommodated prior to a Project level requirement. It is assumed that Project elements will independently report any failure of the GLAS science software to comply with Project-level requirements.

Requirements to be considered for modification, exclusion, or addition must be addressed through the engineering change proposal process according to the software management plan. This process entails analysis by the software development team in concert with the change control authority at the science team level. The

assessment must include information as to the degree of impact of the modification within the maturity level of the design or implementation.

Requirements that are derivatives of the original requirements, either by deduction or by analysis of additional information, are called derived requirements. These requirements are clearly identified and are referenced back to their source(s). Derived requirements may be determined throughout the software life cycle as a result of the design activities and prototyping.

Requirements are identified by a requirement number. The requirement number contains a text string that identifies the allocation of the requirement to a category. The text portion of the string can be:

- GSDS - refers to GLAS Standard Data Software requirements. These requirements are applicable to both subsystems or may be fulfilled by either subsystem. These requirements also include those imposed on the management of the software development or the software development process itself.
- GSDP - refers to GLAS Standard Data Product generation software requirements. These requirements are fulfilled by the I-SIPS Software.
- GISS - refers to the GLAS Instrument Support Software requirements. These requirements are fulfilled by the GLAS IST Software.

The remaining portion of the identifier is a numeric field which uniquely identifies each requirement. The numeric portion of the requirement number allows sufficient digits for the inclusion of derived requirements. The first digit indicates the category of the requirement: 0, 1, 2 - GSDS; 3, 4, 5 - GSDP; 6, 7, 8 - GISS; and 9 - spare. The next 2 digits are allocated to original requirement numbers and the last 2 digits to their derived requirement numbers. For example, for an original requirement number GSDP-30100, the number of the first requirement derived from it will be GSDP-30101.

4.2 Standard Data Software Requirements

4.2.1 External Interface Requirements

The external interface requirements are the requirements for the interfaces between the SDS and its external users. Users include humans and software. Additional external interface requirements are defined with respect to the I-SIPS Software and the IST Software; see Sections 4.3.1 and 4.4.1.

GSDS-01400 The Standard Data Software will interface with the Science Team, I-SIPS Team, Instrument Operations Team, the MOC, the EOSDIS DAAC, the GLAS IST, and the GLAS SCF. The Standard Data Software will interface with the standard data products, ancillary input data, and files supporting instrument operations.

4.2.2 Process and Data Requirements

The requirements in this subsection represent the process and data requirements imposed on the SDS. These include functional requirements placed on the software

processes based on the input data and its source, the output data and its destination, and the data transformations, transactions, and algorithms to be performed on the data. Additional process and data requirements are defined with respect to the I-SIPS Software and the IST Software; see Sections 4.3.2 and 4.4.2.

GSDS-00200 Requisite GLAS data and ancillary data files must be available prior to the generation of a standard data product as specified by the GLAS Data Management Plan.

GSDS-00600 The Standard Data Software will provide instrument health and performance trend data.

4.2.3 Performance and Quality Engineering Requirements

The requirements in this subsection represent the performance and quality engineering requirements imposed on the SDS. This section defines requirements relating to the performance of the software and error recovery. Quality engineering requirements address the aspects particular to software reliability, maintainability, and portability. Testing requirements are defined in this section. Additional performance and quality engineering requirements are defined with respect to the I-SIPS Software and the IST Software; see Sections 4.3.3 and 4.4.3.

GSDS-00300 A test data set shall be developed to be included in the software delivery packages.

GSDS-00400 At a minimum, integration tested deliveries shall be completed for each Project milestone version delivery.

GSDS-00500 Acceptance testing and reporting shall be performed on each version delivery.

GSDS-00700 As a minimum, the following reviews are required: Requirements/ Architectural Design Review, Detailed Design Review, Acceptance Review, and Operations Readiness Reviews.

GSDS-00800 A record log shall be maintained for the configuration status of both the GLAS Standard Data Software and its documentation.

GSDS-01500 Throughout its development the Standard Data Software shall be subjected to informal and formal reviews and walkthroughs.

4.2.4 Safety Requirements

Each requirement in this subsection represents the safety requirements imposed on the SDS. These will include a prioritized list of requirements pertaining to software hazards and their contribution to host system mishaps and user interface operations. The impact of software tasks, their criticality to segment operations, flow of processing information, and operation by the operational personnel should be specified. Any similar specifications impacting software maintenance functions are part of this topic as well. The safety requirements are defined with respect to the I-SIPS Software and the IST Software; see Sections 4.3.4 and 4.4.4.

none specific to Standard Data Software to date

4.2.5 Security and Privacy Requirements

Each requirement in this subsection represents the security and privacy requirements imposed on the SDS. These requirements should include access limitation considerations to the host system and the software segment, and data protection and recovery method specifications. Additional security and privacy requirements are defined with respect to the I-SIPS Software and the IST Software; see Sections 4.3.5 and 4.4.5.

GSDS-00100 The GLAS Standard Data Software baselined code products and documentation will be stored in designated controlled directory and file space to ensure the maintenance of product integrity.

GSDS-00900 The Standard Data Software product integrity must be ensured throughout the software development and the operational mission.

GSDS-01000 Access, userids, passwords, and directory space information will be protected. All operations will be performed in accordance with GSFC and ESDIS security guidelines and requirements.

4.2.6 Implementation Constraints

This subsection presents the constraints imposed on the SDS implementation. These conditions include implementation considerations that impact the design phase for the software segments such as use of certain GFE, COTS, languages, compilers, assemblers, libraries, and architecture. Directions to use existing software or to perform modification of software are contained within this constraint grouping. Any engineering or technical standards applicable or imposed on the design and implementation should be specified here as well. Additional implementation constraints are defined with respect to the I-SIPS Software and the IST Software; see Sections 4.3.6 and 4.4.6.

GSDS-01200 All software development for the GLAS Standard Data Software shall follow a well-defined software life cycle plan with adequate documentation generated and reviews held. The approach taken shall follow the guidelines of the NASA Software Engineering Program (NSEP), to define and document requirements thoroughly before beginning design, and to use prototyping to refine requirements, verify critical areas of the design, and mitigate any higher risk elements.

GSDS-01300 The Engineering Change Proposal process shall be able to accommodate problem reports or change requests submitted by people outside of the Standard Data Software Development Team.

GSDS-01100 The GLAS Standard Data Software Development Team will create and adhere to a set of programming standards and guidelines.

GSDS-01600 The Standard Data Software shall adhere to ESDIS requirements when interfacing to the Project facilities to deliver or retrieve files.

4.2.7 Site Adaptation

Site adaptation requirements are those imposed on the SDS segments to adapt it to the physical environment in which it will operate. These requirements are generally host-site specific and should include any parameters due to installation phase definitions or conditions. Site adaptation requirements are defined with respect to the I-SIPS Software and the IST Software; see Sections 4.3.7 and 4.4.7.

none specific to Standard Data Software to date

4.2.8 Design Goals

This subsection contains the design goals of the software segments. Categories within include correctness, reliability, efficiency, and maintainability of the implemented software. The Standard Data Software design goals are:

GSDS-01700 The design of the Standard Data Software shall provide for 100% fulfillment of the stated and defined requirements.

GSDS-01800 To adequately define and document the requirements and the design of the SDS so that a programmer unfamiliar with the software can easily maintain or modify it.

GSDS-01900 By following a well-defined life cycle for software development, implement software that is highly reliable and maintainable.

Additional design goals are defined with respect to the I-SIPS Software and the IST Software; see Sections 4.3.8 and 4.4.8.

4.3 I-SIPS Software Requirements

4.3.1 External Interface Requirements

This section defines the external interface requirements on the I-SIPS Software. These interfaces include the GLAS Science Team, the I-SIPS Team, the GLAS SCF, and the EOSDIS DAAC. The background reference for these interfaces is found in the Science Software Management Plan (reference document 2.1a).

The following requirements are identified as applicable to I-SIPS Software external interface management.

GSDP-30100 The I-SIPS Software will create GLAS standard products that are to be delivered to the DAAC in the format agreed to by ESDIS.

GSDP-30300 The EDOS collected Level 0 data will be provided from the EOSDIS DAAC to the I-SIPS.

GSDP-30400 The I-SIPS Team shall ensure the availability and integrity of the ancillary data files necessary to produce the GLAS standard data products.

GSDP-31000 The I-SIPS Software shall accept as input: the GLAS instrument packet data, the GLAS standard data products and ancillary data.

4.3.2 Process and Data Requirements

GSDP-30200 The I-SIPS Software shall create the GLAS standard data products, at appropriate data rates and with sufficient precision, to satisfy the requirements of the Science Team and users.

GSDP-30201 GLA01 records shall span one second and shall contain predicted orbit and all telemetered 1064 nm altimeter digitizer data. The GLA01 data shall include the transmitted and returned waveforms and inputs and outputs to the instrument software. The precision will be maintained as that on the level 0 data. One granule of GLA01 shall contain 1/4 revolution of data, splitting at approximately +/- 50 degree latitude.

GSDP-30202 GLA02 records shall span one second and shall contain predicted orbit and all telemetered lidar data. The GLA02 data shall include telemetered cloud digitizer, photon counter and etalon filter data and status values. The precision will be maintained as that on the level 0 data. One granule of GLA02 shall contain 2 revolutions of data beginning at approximately +/- 50 degree latitude boundary. The beginning of the granule will correspond with the beginning of a GLA01 granule.

GSDP-30203 GLA03 records shall span 16 seconds and shall contain all engineering/housekeeping information. The precision will be maintained as that on the level 0 data. One granule of GLA03 shall contain 2 revolutions of data beginning at approximately +/- 50 degree latitude boundary. The granule will be time coincident to a GLA02 granule.

GSDP-30204 GLA04 records shall span one second. The GLA04 is a multifile product, containing individual files for the LRS, LPA, Instrument Star Tracker, Gyro, GPS, Ball Star Trackers, and spacecraft attitude and position data. One granule of GLA04 shall contain the time span of the EDOS level 0 delivery. The precision will be maintained as that on the level 0 data.

GSDP-30205 GLA05 records shall span one second and shall contain all parameters calculated from the waveform and a precision orbit. One granule of GLA05 shall contain 1/4 revolution of data, splitting at approximately +/- 50 degree latitude and is time coincident with GLA01. Unless editing guidelines are implemented (TBD) there will be a one to one correspondence between GLA01 and GLA05 records.

GSDP-30206 GLA06 records shall span one second and shall contain global elevation information and accompanying geodetic corrections. One granule of GLA06 shall contain 1/4 revolution of data, splitting at approximately +/- 50 degree latitude and is time coincident with

GLA01. Unless editing guidelines are implemented (TBD) there will be a one to one correspondence between GLA05 and GLA06 frames.

GSDP-30207 GLA07 records shall span one second and shall contain the attenuated backscatter for the 1064nm and 532 nm lidar data as described in the ATBD for atmospheres. The GLA07 data shall include the precision orbit geolocation. One granule of GLA07 will contain 2 revolutions of data, beginning at approximately +/- 50 degree latitude and is time coincident with GLA02. Unless editing guidelines are implemented (TBD) there will be a one to one correspondence between GLA02 and GLA07 records.

GSDP-30208 GLA08, 09, 10, and 11 records shall span four seconds. Each granule contains 14 revolutions of data, beginning at approximately +/- 50 degree latitude. The beginning of a GLA08, GLA09, GLA10, and GLA11 granule will correspond with the beginning of a GLA07 granule.

GSDP-30209 GLA12, 13, 14, and 15 records shall span one second. Each granule contains 14 revolutions of data, beginning at approximately +/- 50 degree latitude. The beginning of a GLA12, GLA13, GLA14, and GLA15 granule will correspond with the beginning of a GLA06 granule. Each of these products will only contain data within their respective regional mask.

GSDP-30210 All GLAS standard data products (SDPs) will be time-consistent - i.e. for any granule of a product it will have a one to one relationship with any other granule time-wise or be fully contained within a longer granule.

GSDP-30600 The I-SIPS Software will create the GLAS Level 1A data from the Level 0 GLAS instrument data products and the predicted orbit ancillary data.

GSDP-30601 During normal Level 1A processing, GLA01, GLA02, and GLA03 shall be created in one job. The I-SIPS software will be able to create multiple sets of GLA01, 02, and 03 driven by input.

GSDP-30602 Any engineering corrections that need to be applied to data on GLA01 or GLA02 and for which the information is available at creation time of level 1A will be applied to the GLA01 and GLA02 data. Any engineering data required for Level 1B or 2 processing will be carried on the GLA01 or GLA02 records. This is to minimize the need for the GLA03 product to be input to higher levels of SDP processing.

GSDP-30603 GLA04 shall be created when the PDS is made available by EDOS. Input spacecraft telemetry data shall include the Position, Rate, and Attitude Packet (PRAP), and the GPS packet.

GSDP-30700 The I-SIPS Software will create the GLAS Level 1B data from GLAS Level 1A or 1B data and ancillary data.

GSDP-30701 GLAS level 1B waveform parameters, GLA05, shall be created from GLA01 and ancillary data only. Data produced from the waveform that is required as input for the GLA06 generation shall be included on GLA05. If the level 2 LIDAR products are available, flags will be retrieved from the LIDAR products and stored on the GLA05 product.

GSDP-30702 GLAS level 1B elevation data, GLA06, shall be created from GLA05 and ancillary data.

GSDP-30703 GLA05 and GLA06 will be created all in one job or separately. The I-SIPS software will be able to create multiple sets of GLA05 and GLA06 driven by input.

GSDP-30704 GLAS level 1B LIDAR data, GLA07, will be created from GLA02 and ancillary data only.

GSDP-30705 GLAS level 1B LIDAR data will be created using the available MET ancillary data. Otherwise, data from the standard Atmosphere ancillary file will be applied.

GSDP-30800 The I-SIPS Software will create the GLAS Level 2 data from the GLAS Level 1B or Level 2 data and ancillary data.

GSDP-30801 GLA12 will be created from GLA05 and GLA06 and will contain data for all 1 second records on GLA06 for which the location of any shot within that second is within the ice sheet mask ancillary file.

GSDP-30802 GLA13 will be created from GLA05 and GLA06 and will contain data for all 1 second records on GLA06 for which the location of any shot within that second is within the sea ice mask ancillary file.

GSDP-30803 GLA14 will be created from GLA05 and GLA06 and will contain data for all 1 second records on GLA06 for which the location of any shot within that second is within the land mask ancillary file.

GSDP-30804 GLA15 will be created from GLA05 and GLA06 and will contain data for all 1 second records on GLA06 for which the location of any shot within that second is within the ocean mask ancillary file.

GSDP-30805 GLA12-15 will be created all in one job or separately. This means that multiple 1/4 revolution GLA05 and GLA06 granules will be used to create single GLA12 -15 granules. The I-SIPS software will be able to create multiple sets of GLA12 -15 driven by input.

GSDP-30806 GLA08-11 will be created in one processing job. This means that multiple 2 revolution GLA02 granules will be used to create single GLA08-11 granules. The I-SIPS software will be able to create multiple sets of GLA08-11 driven by input.

GSDP-30807 Each set of GLA08-11 products will have identical start and stop times.

GSDP-31100 The I-SIPS Software shall produce metadata describing the data products and their quality.

GSDP-31101 Each granule will have corresponding Metadata that will be delivered.

GSDP-31102 Each SDP granule will have a corresponding Quality Assurance granule.

GSDP-31103 Each granule will have a corresponding browse product.

GSDP-31200 The I-SIPS Software shall properly implement the science algorithms as specified in the Algorithm Theoretical Basis Documents.

GSDP-31300 Automatic or manual Quality Assurance (QA) is provided for each standard data product and ancillary file. Until QA is completed, the file shall be marked as unvalidated. Upon successful completion of QA, the file shall be marked as validated.

GSDP-31400 Fixed metadata (includes the mission description and high-level data product description) will be delivered to the ESDIS as part of the software delivery package and will be updated as necessary.

4.3.3 Performance and Quality Engineering Requirements

GSDP-31500 The I-SIPS Software will be implemented such that it will require minimal modifications in order to port the software to another hardware system.

GSDP-31800 The I-SIPS Software shall incorporate sufficient data and process error handling for error detection, isolation, and recovery.

GSDP-31900 The implemented I-SIPS Software shall be reliable.

GSDP-32000 The implemented I-SIPS Software shall be maintainable.

4.3.4 Safety Requirements

none specific to I-SIPS Software to date

4.3.5 Security and Privacy Requirements

none specific to I-SIPS Software to date

4.3.6 Implementation Constraints

none specific to I-SIPS Software to date

4.3.7 Site Adaptation

none specific to I-SIPS Software to date

4.3.8 Design Goals

The Standard Data Software design goals are:

GSDP-31600 During nominal operations, the implemented I-SIPS Software should be able to process 24 hours of GLAS instrument data into the GLAS standard data products in 4 hours.

GSDP-31700 The data contained in the GLAS standard data products will not be geolocated until the precision orbit data is available.

GSDP-32200 Due to input data updates or processing software changes, the I-SIPS Software shall be capable of reprocessing entire or selected parameters on GLAS standard data product(s).

4.4 GLAS Instrument Support Terminal Software Requirements

4.4.1 External Interface Requirements

The external interfaces to the IST Software include the Mission Operations Center (MOC), the IST, the GLAS Science and Instrument Teams, and the Instrument Operations Team. The following external interfaces requirements are identified.

GISS-60100 The instrument health assessment software will produce routine reports and graphical displays for the GLAS Science and Instrument Operations Teams to review and evaluate.

GISS-60200 The IST software shall interface with the Mission Operations Center to provide instrument command and monitoring capabilities.

GISS-60300 The Instrument Support Terminal will accept real time housekeeping and engineering data from the MOC.

GISS-60700 The Instrument Support Terminal will accept playback Level 0 instrument data from the EOS Polar Ground Station (EPGS).

4.4.2 Process and Data Requirements

GISS-60400 The instrument command software will support the preparation of laser altimeter operational command sequences and the validation of these command sequences.

GISS-60500 The IST Software will support the GLAS Flight Software reprogramming or parameter changes.

GISS-60600 The instrument health assessment software will evaluate data received from both the EOS ICESat spacecraft and the GLAS instrument to determine the health and welfare of the laser and electronics.

4.4.3 Performance and Quality Engineering Requirements

GISS-60800 IST Software shall be developed to be reliable, maintainable, portable, and shall incorporate sufficient data and process error handling for error detection, isolation, and recovery.

4.4.4 Safety Requirements

GISS-60900 The instrument command software will ensure that unauthorized or erroneous commands are not created and sent to the instrument.

GISS-61000 The instrument health assessment software will report data that exceed engineering threshold or limits values, and will raise flags identifying anomalous or erroneous instrument activity which may indicate aberrant sensor behavior or mission-threatening conditions.

4.4.5 Security and Privacy Requirements

GISS-61300 The IST shall be operated in a secure manner to prevent unauthorized use.

4.4.6 Implementation Constraints

GISS-61100 The IST software shall be designed and developed to utilize the mandatory functions of the MOC-supplied tools.

4.4.7 Site Adaptation

none specific to IST Software to date

4.4.8 Design Goals

none specific to IST Software to date

4.5 Traceability to Parent's Design

The requirements are obtained or directly derived from the contents of parent or applicable documentation (called the source). Requirements are parsed or allocated into the appropriate category or subsection based on the text of the requirement and the context in the source(s) from which it is obtained. The maintenance of all SDS requirements and associated descriptions and source document identification information is essential in providing traceability throughout the software development process. The tracking information that maps requirements to their source(s) is stored in the requirements data base; this provides the capability to track the requirements through the design and implementation phases. The tracking information (from the requirements data base) is included in Appendix B in tabular form, to provide the traceability of the requirements to their source(s). In Appendix B, the traceability is shown by listing the requirements' section number (i.e., location of the requirement in this document), requirement number (as listed in this document), the source document number and the source document section.

4.6 Partitioning for Phased Delivery

Several deliveries are planned for the SDS, based on the spacecraft launch schedule and the investigation statement of work. Requirements to be implemented in each of the deliveries of the SDS will be identified in the design documentation. For each delivery, the constituent software unit set is to be clearly identified and specified.

Per the statement of work, the I-SIPS Software will be delivered at three delivery milestones: Beta (V0), Version 1 (V1), and Version 2 (V2). Pre-launch activities and post-launch acceptance and verification testing may necessitate additional final and on-orbit package deliveries as well.

The IST Software will be delivered in up to 3 deliveries. These deliveries do not correspond to the I-SIPS Software deliveries. The IST Software design documentation will define the software deliveries in more detail.

Appendix A
Software Requirements Matrix

This appendix represents a complete listing of the requirements presented in this document.

Table A-1 Software Requirements Matrix

Requirement Number	Description	Status
GSDS-00100	The GLAS Standard Data Software baselined code products and documentation will be stored in designated controlled directory and file space to ensure the maintenance of product integrity.	original
GSDS-00200	Requisite GLAS dataand ancillary data files must be available prior to the generation of a standard data product as specified by the GLAS Data Management Plan.	original
GSDS-00300	A test data set shall be developed to be included in the software delivery packages.	original
GSDS-00400	At a minimum, integration tested deliveries shall be completed for each Project milestones version delivery of the I-SIPS Software.	original
GSDS-00500	Acceptance testing and reporting shall be performed on each version delivery.	original
GSDS-00600	The Standard Data Software will provide instrument health and performance trend data.	original
GSDS-00700	As a minimum, the following reviews are required: Requirements/Architectural Design Review, Detailed Design Review, Acceptance Review, and Operations Readiness Reviews.	original
GSDS-00800	A record log shall be maintained for the configuration status of both the GLAS Standard Data Software and its documentation.	original
GSDS-00900	The Standard Data Software product integrity must be ensured throughout the software development and the operational mission.	original
GSDS-01000	Access, userids, passwords, and directory space information will be protected. All operations will be performed in accordance with GSFC and ESDIS security guidelines and requirements.	original

Table A-1 Software Requirements Matrix (Continued)

Requirement Number	Description	Status
GSDS-01100	The GLAS Standard Data Software Development Team will create and adhere to a set of programming standards and guidelines.	original
GSDS-01200	All software development for the GLAS Standard Data Software shall follow a well-defined software life cycle plan with adequate documentation generated and reviews held. The approach taken shall follow the guidelines of the NASA Software Engineering Program (NSEP), to define and document requirements thoroughly before beginning design, and to use prototyping to refine requirements, verify critical areas of the design, and mitigate any higher risk elements.	original
GSDS-01300	The Engineering Change Proposal process shall be able to accommodate problem reports or change requests submitted by people outside of the Standard Data Software Development Team.	original
GSDS-01400	The Standard Data Software will interface with the Science Team, I-SIPS Team, Instrument Operations Team, the MOC, the EOSDIS DAAC, the GLAS IST, and the GLAS SCF. The Standard Data Software will interface with the standard data products, ancillary input data, and files supporting instrument operations.	original
GSDS-01500	Throughout its development the Standard Data Software shall be subjected to informal and formal reviews and walkthroughs.	original
GSDS-01600	The Standard Data Software shall adhere to ESDIS requirements when interfacing to the Project facilities to deliver or retrieve files.	original
GSDP-30100	The I-SIPS Software will create GLAS standard products that are to be delivered to the DAAC in the format agreed to by ESDIS.	original
GSDP-30200	The I-SIPS Software shall create the GLAS standard data products, at appropriate data rates and with sufficient precision, to satisfy the requirements of the Science Team and users.	original
GSDP-30201	GLA01 records shall span one second and shall contain predicted orbit and all telemetered 1064 nm altimeter digitizer data. The GLA01 data shall include the transmitted and returned waveforms and inputs and outputs to the instrument software. The precision will be maintained as that on the level 0 data. One granule of GLA01 shall contain 1/4 revolution of data, splitting at approximately +/- 50 degree latitude.	derived

Table A-1 Software Requirements Matrix (Continued)

Requirement Number	Description	Status
GSDP-30202	GLA02 records shall span one second and shall contain predicted orbit and all telemetered lidar data. The GLA02 data shall include telemetered cloud digitizer, photon counter and etalon filter data and status values. The precision will be maintained as that on the level 0 data. One granule of GLA02 shall contain 2 revolutions of data beginning at approximately +/- 50 degree latitude boundary. The beginning of the granule will correspond with the beginning of a GLA01 granule.	derived
GSDP-30203	GLA03 records shall span 16 seconds and shall contain all engineering/housekeeping information. The precision will be maintained as that on the level 0 data. One granule of GLA03 shall contain 2 revolutions of data beginning at approximately +/- 50 degree latitude boundary. The granule will be time coincident to a GLA02 granule.	derived
GSDP-30204	GLA04 records shall span one second. The GLA04 is a multifile product, containing individual files for the LRS, LPA, Instrument Star Tracker, Gyro, GPS, Ball Star Trackers, and spacecraft attitude and position data. One granule of GLA04 shall contain the time span of the EDOS level 0 delivery. The precision will be maintained as that on the level 0 data.	derived
GSDP-30205	GLA05 records shall span one second and shall contain all parameters calculated from the waveform and a precision orbit. One granule of GLA05 shall contain 1/4 revolution of data, splitting at approximately +/- 50 degree latitude and is time coincident with GLA01. Unless editing guidelines are implemented (TBD) there will be a one to one correspondence between GLA01 and GLA05 records.	derived
GSDP-30206	GLA06 records shall span one second and shall contain global elevation information and accompanying geodetic corrections. One granule of GLA06 shall contain 1/4 revolution of data, splitting at approximately +/- 50 degree latitude and is time coincident with GLA01. Unless editing guidelines are implemented (TBD) there will be a one to one correspondence between GLA05 and GLA06 frames.	derived
GSDP-30207	GLA07 records shall span one second and shall contain the attenuated backscatter for the 1064nm and 532 nm lidar data as described in the ATBD for atmospheres. The GLA07 data shall include the precision orbit geolocation. One granule of GLA07 will contain 2 revolutions of data, beginning at approximately +/- 50 degree latitude and is time coincident with GLA02. Unless editing guidelines are implemented (TBD) there will be a one to one correspondence between GLA02 and GLA07 records.	derived

Table A-1 Software Requirements Matrix (Continued)

Requirement Number	Description	Status
GSDP-30208	GLA08, 09, 10, and 11 records shall span four seconds. Each granule contains 14 revolutions of data, beginning at approximately +/- 50 degree latitude. The beginning of a GLA08, GLA09, GLA10, and GLA11 granule will correspond with the beginning of a GLA07 granule.	derived
GSDP-30209	GLA12, 13, 14, and 15 records shall span one second. Each granule contains 14 revolutions of data, beginning at approximately +/- 50 degree latitude. The beginning of a GLA12, GLA13, GLA14, and GLA15 granule will correspond with the beginning of a GLA06 granule. Each of these products will only contain data within their respective regional mask.	derived
GSDP-30210	All GLAS standard data products (SDPs) will be time-consistent - i.e. for any granule of a product it will have a one to one relationship with any other granule time-wise or be fully contained within a longer granule.	derived
GSDP-30300	The EDOS collected Level 0 data will be provided from the EOSDIS DAAC to the I-SIPS.	original
GSDP-30400	The I-SIPS Team shall ensure the availability and integrity of the ancillary data files necessary to produce the GLAS standard data products.	original
GSDP-30600	The I-SIPS Software will create the GLAS Level 1A data from the Level 0 GLAS instrument data products and the predicted orbit ancillary data.	original
GSDP-30601	During normal Level 1A processing, GLA01, GLA02, and GLA03 shall be created in one job. The I-SIPS software will be able to create multiple sets of GLA01, 02, and 03 driven by input.	derived
GSDP-30602	Any engineering corrections that need to be applied to data on GLA01 or GLA02 and for which the information is available at creation time of level 1A will be applied to the GLA01 and GLA02 data. Any engineering data required for Level 1B or 2 processing will be carried on the GLA01 or GLA02 records. This is to minimize the need for the GLA03 product to be input to higher levels of SDP processing.	derived
GSDP-30603	GLA04 shall be created when the PDS is made available by EDOS. Input spacecraft telemetry data shall include the Position, Rate, and Attitude Packet (PRAP), and the GPS packet.	derived
GSDP-30700	The I-SIPS Software will create the GLAS Level 1B data from GLAS Level 1A or 1B data and ancillary data.	original

Table A-1 Software Requirements Matrix (Continued)

Requirement Number	Description	Status
GSDP-30701	GLAS level 1B waveform parameters, GLA05, shall be created from GLA01 and ancillary data only. Data produced from the waveform that is required as input for the GLA06 generation shall be included on GLA05. If the level 2 LIDAR products are available, flags will be retrieved from the LIDAR products and stored on the GLA05 product.	derived
GSDP-30702	GLAS level 1B elevation data, GLA06, shall be created from GLA05 and ancillary data.	derived
GSDP-30703	GLA05 and GLA06 will be created all in one job or separately. The I-SIPS software will be able to create multiple sets of GLA05 and GLA06 driven by input.	derived
GSDP-30704	GLAS level 1B LIDAR data, GLA07, will be created from GLA02 and ancillary data only.	derived
GSDP-30705	GLAS level 1B LIDAR data will be created using the available MET ancillary data. Otherwise, data from the standard Atmosphere ancillary file will be applied.	derived
GSDP-30800	The I-SIPS Software will create the GLAS Level 2 data from the GLAS Level 1B or Level 2 data and ancillary data.	original
GSDP-30801	GLA12 will be created from GLA05 and GLA06 and will contain data for all 1 second records on GLA06 for which the location of any shot within that second is within the ice sheet mask ancillary file.	derived
GSDP-30802	GLA13 will be created from GLA05 and GLA06 and will contain data for all 1 second records on GLA06 for which the location of any shot within that second is within the sea ice mask ancillary file.	derived
GSDP-30803	GLA14 will be created from GLA05 and GLA06 and will contain data for all 1 second records on GLA06 for which the location of any shot within that second is within the land mask ancillary file.	derived
GSDP-30804	GLA15 will be created from GLA05 and GLA06 and will contain data for all 1 second records on GLA06 for which the location of any shot within that second is within the ocean mask ancillary file.	derived
GSDP-30805	GLA12-15 will be created all in one job or separately. This means that multiple 1/4 revolution GLA05 and GLA06 granules will be used to create single GLA12 -15 granules. The I-SIPS software will be able to create multiple sets of GLA12 -15 driven by input.	derived

Table A-1 Software Requirements Matrix (Continued)

Requirement Number	Description	Status
GSDP-30806	GLA08-11 will be created in one processing job. This means that multiple 2 revolution GLA02 granules will be used to create single GLA08-11 granules. The I-SIPS software will be able to create multiple sets of GLA08-11 driven by input.	derived
GSDP-30807	Each set of GLA08-11 products will have identical start and stop times.	derived
GSDP-30900	Metadata will include an assessment of the software performance.	original
GSDP-31000	The I-SIPS Software shall accept as input: the GLAS instrument packet data, the GLAS standard data products and ancillary data.	original
GSDP-31100	The I-SIPS Software shall produce metadata describing the data products and their quality.	original
GSDP-31101	Each granule will have corresponding Metadata that will be delivered.	derived
GSDP-31102	Each SDP granule will have a corresponding Quality Assurance granule.	derived
GSDP-31103	Each granule will have a corresponding browse product.	derived
GSDP-31200	The I-SIPS Software shall properly implement the science algorithms as specified in the Algorithm Theoretical Basis Documents.	original
GSDP-31300	Automatic or manual Quality Assurance (QA) is provided for each standard data product and ancillary file. Until QA is completed, the file shall be marked as unvalidated. Upon successful completion of QA, the file shall be marked as validated.	original
GSDP-31400	Fixed metadata (includes the mission description and high-level data product description) will be delivered to the ESDIS as part of the software delivery package and will be updated as necessary.	original
GSDP-31500	The I-SIPS Software will be implemented such that it will require minimal modifications in order to port the software to another hardware system.	original
GSDP-31800	The I-SIPS Software shall incorporate sufficient data and process error handling for error detection, isolation, and recovery.	original
GSDP-31900	The implemented I-SIPS Software shall be reliable.	original
GSDP-32000	The implemented I-SIPS Software shall be maintainable.	original

Table A-1 Software Requirements Matrix (Continued)

Requirement Number	Description	Status
GISS-60100	The instrument health assessment software will produce routine reports and graphical displays for the GLAS Science and Instrument Operations Teams to review and evaluate.	original
GISS-60200	The IST software shall interface with the Mission Operations Center to provide instrument command and monitoring capabilities.	original
GISS-60300	The Instrument Support Terminal will accept EDOS-collected housekeeping and engineering data from the MOC.	original
GISS-60400	The instrument command software will support the preparation of laser altimeter operational command sequences and the validation of these command sequences.	original
GISS-60500	The IST Software will support the GLAS Flight Software reprogramming or parameter changes.	original
GISS-60600	The instrument health assessment software will evaluate data received from both the EOS ICESat spacecraft and the GLAS instrument to determine the health and welfare of the laser and electronics.	original
GISS-60700	The Instrument Support Terminal will accept EDOS-collected Level 0 instrument data from the EOSDIS DAAC.	original
GISS-60800	IST Software shall be developed to be reliable, maintainable, portable, and shall incorporate sufficient data and process error handling for error detection, isolation, and recovery.	original
GISS-60900	The instrument command software will ensure that unauthorized or erroneous commands are not created and sent to the instrument.	original
GISS-61000	The instrument health assessment software will report data that exceed engineering threshold or limits values, and will raise flags identifying anomalous or erroneous instrument activity which may indicate aberrant sensor behavior or mission-threatening conditions.	original
GISS-61100	The IST software shall be designed and developed to utilize the mandatory functions of the MOC-supplied tools.	original
GISS-61300	The IST shall be operated in a secure manner to prevent unauthorized use.	original

Appendix B
Requirements Traceability Matrix

This Appendix provides a trace of the original requirements listed in this document to their sources. The requirements that were derived from the original requirements are documented within this document.

Table B-1 "Requirements Traceability Matrix" is organized with the following information:

- Requirements Document Section indicates the section number within this document containing the requirement.
- Requirement Number indicates the requirement number associated with the requirement in text of this document.
- Source Document Number indicates the document number or unique identifier for the original requirement. Table B-2 "Source Documents"lists the source document number with the source document name.
- Source Document Section indicates the section number containing the requirement within the parent or applicable document.

Table B-1 Requirements Traceability Matrix

Requirements Document Section	Requirement Number	Source Document Number	Source Document Section
4.2.5	GSDS-00100	GLAS-SMP-1100	10.2.2.1
4.2.2	GSDS-00200	GLAS-DMP-1200	4.0
4.2.3	GSDS-00300	GLAS-SMP-1100 GLAS-SMP-1100	4.2.1.3.2 4.2.1.2.2
4.2.3	GSDS-00400	GLAS-SMP-1100 GLAS-SMP-1100	4.2.1.2.2 4.2.1.3.2
4.2.3	GSDS-00500	GLAS-SMP-1100 GLAS-SMP-1100	4.2.1.2.3 4.2.1.3.3
4.2.2	GSDS-00600	GLAS-SMP-1100	3.0
4.2.3	GSDS-00700	GLAS-SMP-1100	6.3
4.2.3	GSDS-00800	GLAS-SMP-1100	10.2.3
4.2.5	GSDS-00900	GLAS-SMP-1100	10.2.2.1
4.2.5	GSDS-01000	GLAS-SMP-1100	10.2.2.1
4.2.3	GSDS-01100	GLAS-SMP-1100	6.1.1

Table B-1 Requirements Traceability Matrix (Continued)

Requirements Document Section	Requirement Number	Source Document Number	Source Document Section
4.2.6	GSDS-01200	GLAS-SMP-1100	6.1.1
4.2.6	GSDS-01300	GLAS-SMP-1100	6.1.3
4.2.1	GSDS-01400	GLAS-SMP-1100	6.4.1
4.2.6	GSDS-01500	GLAS-SMP-1100 GLAS-SMP-1100 GLAS-SMP-1100	8.2 8.1 4.2.1.2.3
4.2.6	GSDS-01600	GLAS-SMP-1100	5.4.1
4.3.1	GSDP-30100	GLAS-SMP-1100	3.1
4.3.2	GSDP-30200	GLAS-SMP-1100	3.1
4.3.1	GSDP-30300	GLAS-SMP-1100	3.1
4.3.1	GSDP-30400	GLAS-DMP-1200	5
4.3.2	GSDP-30600	GLAS-DMP-1200	4.1
4.3.2	GSDP-30700	GLAS-DMP-1200 GLAS-DMP-1200	4.2 4.3
4.3.2	GSDP-30800	GLAS-DMP-1200 GLAS-DMP-1200 GLAS-DMP-1200 GLAS-DMP-1200 GLAS-DMP-1200	4.4 4.9 4.6 4.5 4.7
4.3.2	GSDP-30900	GLAS-SMP-1100	3.1
4.3.1	GSDP-31000	GLAS-SMP-1100	3.1
4.3.2	GSDP-31100	GLAS-SMP-1100	3.1
4.3.2	GSDP-31200	GLAS-SMP-1100	4.2.1.2.2
4.3.2	GSDP-31300	GLAS-DMP-1200	3.5
4.3.2	GSDP-31400	GLAS-SMP-1100	4.2.1.2.3
4.3.3	GSDP-31500	GLAS-SMP-1100 GLAS-SMP-1100	6.1.1 5.4.1
4.3.3	GSDP-31800	GLAS-SMP-1100	6.1.1
4.3.3	GSDP-31900	GLAS-SMP-1100	6.1.1
4.3.3	GSDP-32000	GLAS-SMP-1100	6.1.1
4.2.3	GSDP-32100	GLAS-SMP-1100	4.2.1.2.2
4.4.1	GISS-60100	GLAS-SMP-1100	3.2

Table B-1 Requirements Traceability Matrix (Continued)

Requirements Document Section	Requirement Number	Source Document Number	Source Document Section
4.4.1	GISS-60200	GLAS-SMP-1100	3.2
4.4.1	GISS-60300	GLAS-DMP-1200	3.2.1
4.4.2	GISS-60400	GLAS-SMP-1100	3.2
4.4.2	GISS-60500	GLAS-SMP-1100	3.2
4.4.2	GISS-60600	GLAS-SMP-1100	3.2
4.4.1	GISS-60700	GLAS-DMP-1200	3.2.2
4.4.3	GISS-60800	GLAS-SMP-1100	6.1.1
4.4.4	GISS-60900	GLAS-SMP-1100	3.2
4.4.4	GISS-61000	GLAS-SMP-1100	3.2
4.4.6	GISS-61100	GLAS-SMP-1100	5.4.1
4.4.5	GISS-61300	GLAS-SMP-1100	4.3.4.2

Table B-2 Source Documents

Document Number	Document Name
GLAS-SMP-1100	GLAS Science Software Management Plan
GLAS-DMP-1200	GLAS Science Data Management Plan

Abbreviations and Acronyms

DAAC	Distributed Active Archive Center
ECP	Engineering Change Proposal
ECS	EOSDIS Core System
EDOS	EOS Data and Operations System
EOC	EOS Operating Center
EOS	NASA Earth Observing System Mission Program
EOSDIS	Earth Observing System Data and Information System
ESDIS	Earth Science Data and Information System
GIST	GLAS IST Software requirement
GLAS	Geoscience Laser Altimeter System instrument or investigation
GPS	Global Positioning System
GSDS	GLAS Standard Data Software
GSFC	NASA Goddard Space Flight Center
GSFC/WFF	NASA Goddard Space Flight Center/Wallops Flight Facility
GSSRD	GLAS Science Software Requirements Document
ICESat	Ice, Clouds and land Elevation Satellite
I-SIPS	ICESat Science Investigator-led Processing Systems
ISS	I-SIPS Software
IST	GLAS Instrument Support Terminal Facility and workstation(s)
LASER	Light Amplification by Stimulated Emission of Radiation
LIDAR	Light Detection and Ranging
N/A	Not (/) Applicable
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
POD	Precision Orbit Determination
SCF	GLAS investigation Science Computing Facility
SDPS	ECS Science Data Processing Segment
SDS	Standard Data Software

SDT	SDS Development Team
SDMP	GLAS Science Data Management Plan
SSMP	GLAS Science Software Management Plan
TBD	to be determined, to be done, or to be developed
UNIX	the operating system jointly developed by AT&T Bell Laboratories and the University of California-Berkeley System Division

Glossary

aggregate	A collection, assemblage, or grouping of distinct data parts to make a whole. It is generally used to indicate the grouping of GLAS data items, arrays, elements, and EOS parameters into a data record. For example, the collection of Level 1B EOS Data Parameters gathered to form a one-second Level 1B data record. It could be used to represent groupings of various GLAS data entities such as data items aggregated as an array, data items and arrays aggregated into a GLAS Data Element, GLAS Data Elements aggregated as an EOS Data Parameter, or EOS Data Parameters aggregated into a Data Product record.
array	An ordered arrangement of homogenous data items that may either be synchronous or asynchronous. An array of data items usually implies the ability to access individual data items or members of the array by an index. An array of GLAS data items might represent the three coordinates of a georeference location, a collection of values at a rate, or a collection of values describing an altimeter waveform.
file	A collection of data stored as records and terminated by a physical or logical end-of-file (EOF) marker. The term usually applies to the collection within a storage device or storage media such as a disk file or a tape file. Loosely employed, it is used to indicate a collection of GLAS data records without a standard label. For the Level 1A Data Product, the file would constitute the collection of one-second Level 1A data records generated in the SDPS working storage for a single pass.
header	A text and/or binary label or information record, record set, or block, prefacing a data record, record set, or a file. A header usually contains identifying or descriptive information, and may sometimes be embedded within a record rather than attached as a prefix.
item	Specifically, a data item. A discrete, non-decomposable unit of data, usually a single word or value in a data record, or a single value from a data array. The representation of a single GLAS data value within a data array or a GLAS Data Element.
label	The text and/or binary information records, record set, block, header, or headers prefacing a data file or linked to a data file sufficient to form a labeled data product. A standard label may imply a standard data product. A label may consist of a single header as well as multiple headers and markers depending on the defining authority.
Level 0	The level designation applied to an EOS data product that consists of raw instrument data, recorded at the original resolution, in time order, with any duplicate or redundant data packets removed.
Level 1A	The level designation applied to an EOS data product that consists of reconstructed, unprocessed Level 0 instrument data, recorded at the full resolution with time-referenced data records, in time order. The data are annotated with ancillary information including radiometric and geometric calibration coefficients, and georeferencing parameter data (i.e., ephemeris data). The included, computed coefficients and parameter data have not, however, been applied to correct the Level 0 instrument data contents.

Level 1B	The level designation applied to an EOS data product that consists of Level 1A data that have been radiometrically corrected, processed from raw data into sensor data units, and have been geolocated according to applied georeferencing data.
Level 2	The level designation applied to an EOS data product that consists of derived geophysical data values, recorded at the same resolution, time order, and georeference location as the Level 1A or Level 1B data.
Level 3	The level designation applied to an EOS data product that consists of geophysical data values derived from Level 1 or Level 2 data, recorded at a temporally or spatially resampled resolution.
Level 4	The level designation applied to an EOS data product that consists of data from modeled output or resultant analysis of lower level data that are not directly derived by the GLAS instrument and supplemental sensors.
metadata	The textual information supplied as supplemental, descriptive information to a data product. It may consist of fixed or variable length records of ASCII data describing files, records, parameters, elements, items, formats, etc., that may serve as catalog, data base, keyword/value, header, or label data. This data may be parsable and searchable by some tool or utility program.
orbit revolution	The passage of time and spacecraft travel signifying a complete journey around a celestial or terrestrial body. For GLAS and the EOS LASER ALT spacecraft each orbit revolution starts at the time when the spacecraft is on the equator traveling toward the North Pole, continues through the equator crossing as the spacecraft ground track moves toward the South Pole, and terminates when the spacecraft has reached the equator moving northward from the South Polar region.
parameter	Specifically, an EOS Data Parameter. This is a defining, controlling, or constraining data unit associated with a EOS science community approved algorithm. It is identified by an EOS Parameter Number and Parameter Name. An EOS Data Parameter within the GLAS Data Product is composed of one or more GLAS Data Elements
pass	A sub-segment half of an orbit, it may consist of the ascending or descending portion of an orbit (e.g., a descending pass would consist of the ground track segment beginning with the northernmost point of travel through the following southernmost point of travel), or the segment above or below the equator (e.g., either the northern or southern hemisphere portion of the ground track on any orbit).
product	Specifically, the Data Product or the EOS Data Product. This is implicitly the labeled data product or the data product as produced by software on the SDPS or SCF. A GLAS data product refers to the data file or record collection either prefaced with a product label or standard formatted data label or linked to a product label or standard formatted data label file. Loosely used, it may indicate a single pass file aggregation, or the entire set of product files contained in a data repository.
record	A specific organization or aggregate of data items. It represents the collection of EOS Data Parameters within a given time interval, such as a one-second data record. It is the first level decomposition of a product file.

Standard Data Product	Specifically, a GLAS Standard Data Product. It represents an EOS LASER ALT/GLAS Data Product produced on the EOSDIS SDPS for GLAS data product generation or within the GLAS Science Computing Facility using EOS science community-approved algorithms. It is routinely produced and is intended to be archived in the EOSDIS data repository for EOS user community-wide access and retrieval.
variable	Usually a reference in a computer program to a storage location.

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13. ABSTRACT *(Maximum 200 words)*

This document addresses the software requirements of the GLAS Standard Data Software (SDS) supporting the GLAS instrument on the EOS ICESat Spacecraft. This Software Requirements Document represents the initial collection of the technical engineering information for the GLAS SDS. This information is detailed within the second of four main volumes of the Standard documentation, the Product Specification volume. This document is a "roll-out" from the governing volume outline containing the Concept and Requirements sections.

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